

Abstract

A Green's function approach to simulate DNA damage by the indirect effect

By Ianik Plante¹ and Francis A. Cucinotta²

¹Universities Space Research Association, Houston, TX, 77058

²NASA Johnson Space Center, Houston, TX, 77058

The DNA damage is of fundamental importance in the understanding of the effects of ionizing radiation. DNA is damaged by the direct effect of radiation (e.g. direct ionization) and by indirect effect (e.g. damage by $\cdot\text{OH}$ radicals created by the radiolysis of water). Despite years of research, many questions on the DNA damage by ionizing radiation remains. In the recent years, the Green's functions of the diffusion equation (GFDE) have been used extensively in biochemistry [1], notably to simulate biochemical networks in time and space [2]. In our future work on DNA damage, we wish to use an approach based on the GFDE to refine existing models on the indirect effect of ionizing radiation on DNA. To do so, we will use the code RITRACKS [3] developed at the NASA Johnson Space Center to simulate the radiation track structure and calculate the position of radiolytic species after irradiation. We have also recently developed an efficient Monte-Carlo sampling algorithm for the GFDE of reversible reactions with an intermediate state [4], which can be modified and adapted to simulate DNA damage by free radicals. To do so, we will use the known reaction rate constants between radicals ($\cdot\text{OH}$, e^-_{aq} , $\text{H}\cdot$, ...) and the DNA bases, sugars and phosphates and use the sampling algorithms to simulate the diffusion of free radicals and chemical reactions with DNA. These techniques should help the understanding of the contribution of the indirect effect in the formation of DNA damage and double-strand breaks.

References:

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